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DETERMINING SAP SWEETNESS IN SMALL SUGAR MAPLE TREES

Abstract.—Describes a technique based on the use of a hypodermic needle for determining sap-sugar concentrations in small trees. The technique is applicable to pot cultures in greenhouses and also, with the use of a movable shelter, to seedlings in nursery beds.

One of the major objectives in our research on sugar maple at Burlington, Vt., is to develop high-yielding trees for the sugar maple industry. Both sexual and vegetative propagation are used in this program to produce superior stock. This work could be greatly facilitated if we had a way to determine the sap-sugar concentration in small sugar maple seedlings in the nursery or greenhouse. Progress will hinge to a considerable degree on our being able to make early selections for sap sweetness among the various progenies.

A means for determining sap-sugar concentration in very small trees also would be highly useful in fundamental physiological research in sugar maple.

Any technique for measuring sap-sugar concentration must be applicable both to pot cultures used in greenhouse studies and to stock growing in nursery beds. This note reports an attempt to develop such a technique based on the use of a hypodermic needle to obtain sap samples.

Materials

Eighty 2-year-old sugar maple seedlings, produced from randomly collected seed sown in a nursery bed in the spring of 1963, were used in the study. The seedlings were 12 to 18 inches tall, and 3/16 to 3/8 inch in diameter 3 inches above ground. During the first week of December 1965, 40 of these seedlings were potted in 8-inch plastic pots

Figure 1.—Tapping potted seedlings in the greenhouse. Complete hypodermic assembly used in earlier trials is shown at right; detached needle, which worked equally well and was more convenient to use, is shown inserted in a seedling stem at left.

and placed in a room maintained at approximately 33°F. and 85 to 90 percent relative humidity. The 40 seedlings remaining in the nursery bed were enclosed in a 4- by 5- by 20-foot shelter made of polyethylene over a wooden frame. The seedlings had been mulched in November with 4 to 6 inches of leaf litter.

All the seedlings were left under these cold conditions until mid-February, when we first tried to sample for sap-sugar concentration. The instrument we used for tapping was a #22-G Huber point hypodermic needle. At first we used the complete hypodermic syringe, but we found that the vacuum created by the syringe did not increase the flow of sap. So, for most of the work, we used only the detached needle (fig. 1).

Sugar percentages in sap samples were read in a small, portable, hand-held refractometer of the type commonly used in the maple industry for sap-sugar determinations in the field.

Procedures and Results

The most effective tapping technique was to insert the hypodermic needle into the stem to a depth of 1/16 to 1/8 inch in an upward direction at an angle of about 45°. Three to 4 inches above the soil surface appeared to be the most productive tapping height. At best only a small volume of sap was obtained per seedling—usually less than 0.1 ml. This amount is minimal for determining sugar concentration with a standard field refractometer.

In general, sap flow could be induced in the potted seedlings by transferring them from the cold room to a greenhouse where the temperature was near 50° F. Sap usually would flow within 10 minutes after the seedlings were moved to the greenhouse. After one tapping, another flow could be induced 1 or more days later by re-cycling the plants through the cold storage-greenhouse treatment.

In the nursery bed, sap would not flow when the soil was frozen. Some soil freezing had occurred in the bed before the shelter was installed and may have increased afterward. We had to thaw the soil with a heater and then keep it protected from re-freezing. When the soil had been thawed, raising the temperature inside the shelter 10° to 15° F. would induce sap flow, even on days when air temperatures outside were near freezing or below. Later in the season, sap flow could be obtained without artificial heat on days when conditions were favorable.

Because seedling roots are generally shallow, the soil did not have to freeze very deeply to prevent sap flow. With soil frozen to a depth of 8 to 10 inches, sap sometimes would flow from the twigs of larger trees and not from nearby seedlings. Presumably, in such circumstances, most or all of the root system of small seedlings was frozen, whereas only the surface roots of larger trees were frozen.

The sap-flow mechanism in small seedlings is sensitive to temperature changes, and it will operate only within rather critical temperature limits. When unsheltered seedlings are being tapped, slight wind movements over them, which apparently reduce their temperature, can alter the previously favorable conditions enough to stop the flow. External temperature changes appear to be transmitted very rapidly to the internal sap-flow mechanism.

The small seedlings used in this study never produced a continuous sap flow, as larger trees do. The total sap yield from a tapping was always obtained within 10 minutes after the flow started. Apparently a hydrostatic pressure is created within the seedling when conditions

favorable for sap flow are developing. When the seedling is tapped, this pressure is released with the flow of a small amount of sap, and the flow then ceases. The insertion of two or more needles in the same general area of a seedling stem did not appreciably increase the sap yield. After a seedling is moved into a warm environment, its flow potential is sustained for only a short time—usually no longer than 30 minutes.

Suggestions for Use of the Method

The hypodermic needle method would be of greatest use in making selections among stock in the nursery. However, the environmental factors important in inducing sap flow will be more difficult to control in the nursery than in the greenhouse.

For early spring tapping in the nursery, the soil must be protected from freezing. This will require application of a heavy mulch in the fall as a minimum treatment. An enclosed shelter will be helpful as additional protection. Although feasible for small sections of a nursery bed, fixed shelters obviously are impractical for larger areas. Moreover, fixed shelters create other problems: sunny days may raise inside temperatures enough to induce early bud break, which may then be followed by frost injury.

Probably the most efficient and practical way to use this method in the nursery will be to delay sampling until midway or later in the sugaring season when the soil has thawed, and then use a portable shelter as needed to provide a suitable environment for inducing sap flow. Mulch, applied to the beds in the fall, would protect the soil from freezing during any recurring cold spells. This combination of mulch protection and portable shelter should permit fairly extensive sampling of nursery seedlings during the later, milder part of the sugaring season.

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